Table 7-11. Site and COPC retention table for the WAG 4 ecological risk assessment.

OU	Site	Retained in Human Health Assessment	Reason Retained for Further Assessment[a]	Eliminated as a Concern in the ERA[a]	COPCs[b]
Sites included in the human health risk assessment					
4-02	CFA-13	Yes	C		Antimony, Aroclor-1254, arsenic, BaA, BbF, B(g,h,i)P, BkF, cadmium, chromium, chrysene, copper, I(1,2,3cd)P, lead, mercury, nickel, pyrene, selenium, silver, and zinc
	CFA-15	Yes	C		Copper and mercury
4-05	CFA-04	Yes	C	R	Aroclor-1254, arsenic, barium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, nitrate, silver, and vanadium
	CFA-06	Yes	C		Arsenic and lead
	CFA-17/47	Yes	C		BaP, BbF, B(g,h,i)P
4-07	CFA-12	Yes	C	R	PCP
4-08	CFA-08	Yes	C	R	Aroclor-1254, arsenic, BaP, barium, cadmium, chloromethane, chromium, copper, lead, mercury, nickel, selenium, and silver
4-09	CFA-10	Yes	C		Antimony, Aroclor-1254, arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, and zinc
	CFA-26	Yes	C		TPH
4-11	CFA-05 Ditch	Yes	C	R	Arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, vanadium, and zinc
	CFA-05 Pond	Yes	C	R	4-methyl-2-pentanone, arsenic, cadmium, chromium, copper, lead, maganese, and zinc
Sites not included in the human health risk assessment					
4-03	CFA-21	No	C		TPH
	CFA-23	No	C		TPH
	CFA-24	No	C		TPH
	CFA-25	No		C	
	CFA-27	No	C		TPH
	CFA-28	No	C		TPH

Table 7-11. (continued).

OU	Site	Retained in Human Health Assessment	Reason Retained for Further Assessment[a]	Eliminated as a Concern in the ERA[a]	COPCs[b]
	CFA-29	No		C	
	CFA-30	No	C		TPH
	CFA-31	No	C		TPH and xylene
	CFA-32	No		C	
	CFA-34	No	C		TPH
	CFA-37	No	C		TPH
	CFA-38	No	C		TPH
	CFA-45	No	C		TPH
4-04	CFA-40	No	C		TPH
	CFA-41	No	C		TPH
4-05	CFA-50	No		C	
4-06	CFA-43	No	C		Lead
	CFA-44	No	C		Lead
4-07	CFA-48	No	C		Lead and mercury
4-08	CFA-49	No		R	
4-12	CFA-01	No	C		BaP, BbF, B(g,h,i), BkF, chromium, chrysene, copper, I(1,2,3-cd)P, lead, silver, and zinc
	CFA-02	No	C		2-methynaphthalene, 4-methyl-2-pentanone, acetone, arsenic, BaP, BbF, B(g,h,i)P, BkF, chrysene, D(a,h)A, dibenzofuran, I(1,2,3-cd)P, lead, mercury, and PCP
4-13	CFA-51	No	C	R	Cadmium, copper, lead, selenium. and zinc

a. R = radionuclides; C = nonradiological chemicals.

b. Aroclor-1254 = PCB (polychlorinated biphenol); BaP = benzo(a)pyrene; BbF = benzo(b)fluoranthene; B(g,h,i)P = benzo(g,h,i) perylene; BkF = benzo(k)fluoranthene; D(a,h)A = dibenz(a,h)anthracene; I(1,2,3-cd)P = indeno(1,2,3-cd)pyrene; PCP = pentachlorophenol; TPH = total petroleum hydrocarbons

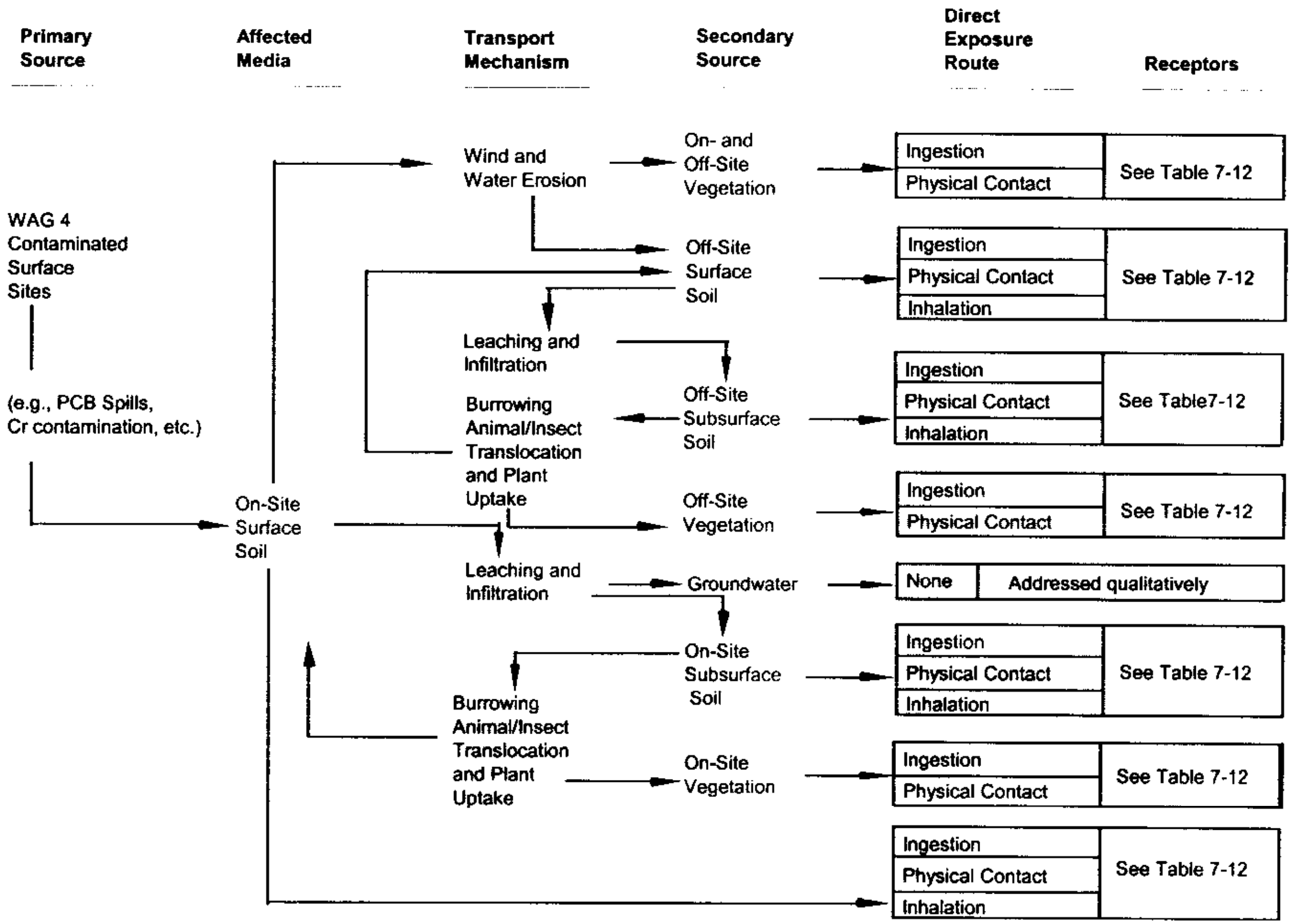

Figure 7-4. Ecological pathways/exposure model for WAG 4 surface contamination.

- Burrowing animal translocation.

Transportation of contaminated soils through these mechanisms may result in contamination of various other media or secondary sources, including the following onsite and offsite sources:

- Surface water
- Surface soil
- Subsurface soil
- Vegetation.

Receptors having potential for direct exposure to WAG 4 surface soils are presented in Table 7-12. Ecological receptors can be exposed to contaminated media directly through ingestion of contaminated vegetation, water, and prey; incidental ingestion of soil; or through physical contact or inhalation. Inhalation and physical contact, however, are considered to play minor roles in the exposure to surface contamination for WAG 4 and are not evaluated in this assessment. The functional groups identified as having direct exposure include most terrestrial avian, mammalian, reptilian, and insect species potentially present in the WAG 4 area.

7.2.7.2 Subsurface Soil. The ecological pathways/exposure model for WAG 4 contaminated subsurface soil is presented on Figure 7-5. Many of the WAG 4 sites of concern are contaminated subsurface soil sites resulting from buried contaminated soil or sediments, leaking underground storage tanks, and past surface spills followed by leaching. For the WAG ERA analysis, subsurface soil is defined between 15 cm and 3 m (0.5 to 10 ft). Contaminants in subsurface soil can be transported to ecological receptors by plant uptake and translocation by burrowing animals. Contamination at depths greater than 3 m (10 ft) below the surface are considered inaccessible to ecological receptors, since this is generally below the root zone of plants and the burrowing depth of ground-dwelling animals.

Once contaminated soil is brought close to the surface, transport and exposure scenarios for ecological receptors are the same as for surface soil. For subsurface contamination, inhalation and direct contact (by burrowing animals) are likely more important exposure routes than for surface contamination.

Receptors having potential for direct exposure to WAG 4 subsurface soil contamination include animals dwelling below ground and deep rooting plants (see Table 7-12). Because subsurface soil contamination may be translocated to the surface by plant uptake and burrowing animals, other terrestrial species also have some potential for exposure through this pathway.

7.2.7.3 Surface Water. Surface water flow and accumulation in and around WAG 4 are generally limited to spring runoff and intense precipitation events and no major natural drainages occur at WAG 4. WAG 4 surface flows are limited to localized runoff, particularly from paved areas of the existing facilities. None of the sites of concern evaluated in this ERA have standing surface water and no pathway to ecological receptors exists for groundwater at WAG 4. Consequently, these pathways were not evaluated as part of the assessment.

Table 7-12. Summary of WAG 4 exposure media and ingestion route for INEEL functional groups.

Receptor	Surface Soils	Subsurface Soils	Vegetation	Sediments	Prey Consumption: Invertebrates	Prey Consumption: Mammals	Prey Consumption: Birds
Avian herbivores (AV122)	x		x				
Avian insectivores (AV210A)				x	x		
Avian insectivores (AV222)	x				x		
Avian insectivores (AV232)				x	x		
Avian carnivores (AV310)X	x					x	x
Northern goshawk	x					x	x
Peregrine falcon	x					x	
Avian carnivores (AV322)X						x	
Bald eagle						x	
Ferruginous hawk						x	
Loggerhead shrike						x	x
Avian carnivores (AV322A)X Burrowing owl	x	x			x	x	
Avian omnivores (AV422)			x		x	x	x
Mammalian herbivores (M122)	x		x				
Mammalian herbivores (M122A)X	x	x	x				
Pygmy rabbit	x	x	x				
Mammalian insectivores (M210A)X	x				x		
Townsend's western big-eared bat	x				x		
Small-footed myotis	x				x		
Long-eared myotis					x		
Mammalian insectivores (M222)	x			x	x		
Mammalian carnivore (M322)	x					x	
Mammalian omnivores (M422)	x	x	x		x		
Reptilian insectivores (R222)— Sagebrush lizard	x				x		
Reptilian carnivores (R322)	x					x	
Plants-uptake							

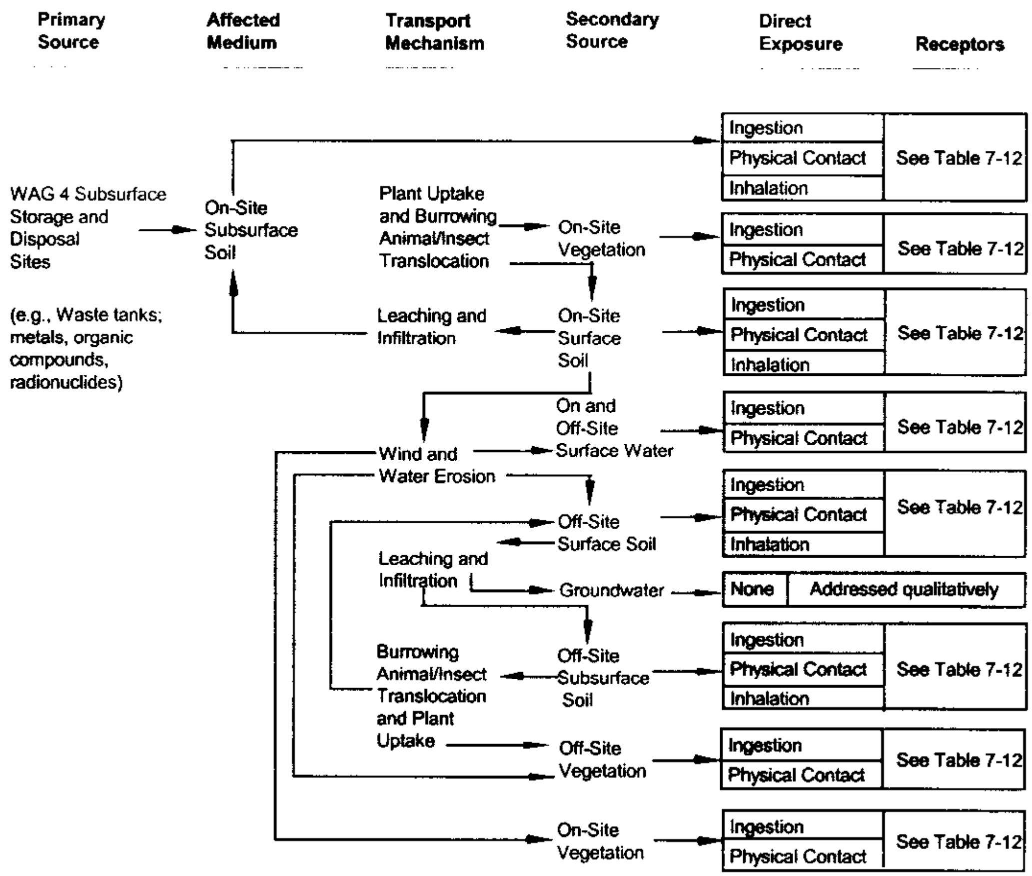

Figure 7-5. Ecological pathways/exposure model for WAG 4 subsurface storage and disposal sites.

7.2.8 Conceptual Site Model

The pathways/exposure models for surface soil, subsurface soil, and surface water were integrated to produce the WAG 4 CSM shown on Figure 7-6. This model reflects both direct (previous sections) and indirect (i.e., predation) receptor exposure pathways for WAG 4 COPCs.

7.2.9 Development of Assessment Endpoints

Assessment endpoints are "formal expressions of the actual environmental values that are to be protected" (Suter 1989). Assessment endpoints developed for this WAG ERA are presented on Table 7-13. The endpoints were developed around the protection of INEEL biota represented by functional groups and individual T/E and sensitive species known to exist at WAG 4 and identified as having the potential for exposure to COPCs. Each T/E and sensitive species with the potential for exposure is addressed individually in the risk analysis, whereas potential effects to other receptors of concern are dealt with at the functional group level. Assessment endpoints defined for the WAG 4 ERA reflect OU 10-04 hazard/policy goals discussed in the Guidance Manual (VanHorn et al. 1995) and incorporate the suggested criteria for developing assessment endpoints, including ecological relevance and policy goals (EPA 1992; Suter 1993).

These assessment endpoints are the focus for WAG ERA risk characterization and link the measurement endpoints to the WAG ERA goals. The primary objective of this WAG ERA is to identify COPCs and levels of those contaminants that represent potential risk to WAG 4 ecological components. Consequently, toxic effects to ecological components as a result of exposure to COPCs were considered a primary concern for WAG 4 biota. Although adverse effects due to physical stressors are also of concern in evaluating potential risks to INEEL ecological components, these effects are not addressed by the WAG ERA. This was used to establish the potential for contaminants to contribute to ecological risk to WAG 4 individuals and populations. The HQ is used to indicate whether or not a potential for adverse effects exists. The use of the HQ as an indicator of effects is discussed in detail in Section 7.4.1.

7.2.10 Measurement Endpoint Selection

This section describes the selection of measurement endpoints for the WAG ERA. Measurement endpoints are measurable responses of ecological receptors to contaminants that can be related to ERA assessment endpoints. For this ERA, WAG 4 ecological components (i.e., flora and fauna) were not measured or surveyed directly. Rather, published references were used as the primary sources of ecological and toxicological data from which measurement endpoints were derived. Values extracted from these references were used to calculate dose for all ecological receptors and to develop toxicity reference values (TRVs) for contaminants.

Table 7-14 summarizes the WAG 4 ERA assessment endpoints. It also contains published values for species' dietary habits, home ranges, site use, exposure duration (ED), soil ingestion, food digestion, and body weights for the representative species. Quantified critical exposure levels (QCELs) and adjustment factors (AFs) were constructed from the literature to develop appropriate TRVs for receptors associated with WAG 4 contaminant pathways. Criteria for development of these TRVs are discussed in Section 7.4.1. In general, the criteria incorporate the requirements for appropriate endpoints, including relevance to an assessment endpoint, applicability to the route of exposure, use of existing data, and consideration of scale (VanHorn et al. 1995).

The exposure-point concentrations of contaminants in each medium were used to calculate dose for each affected receptor.

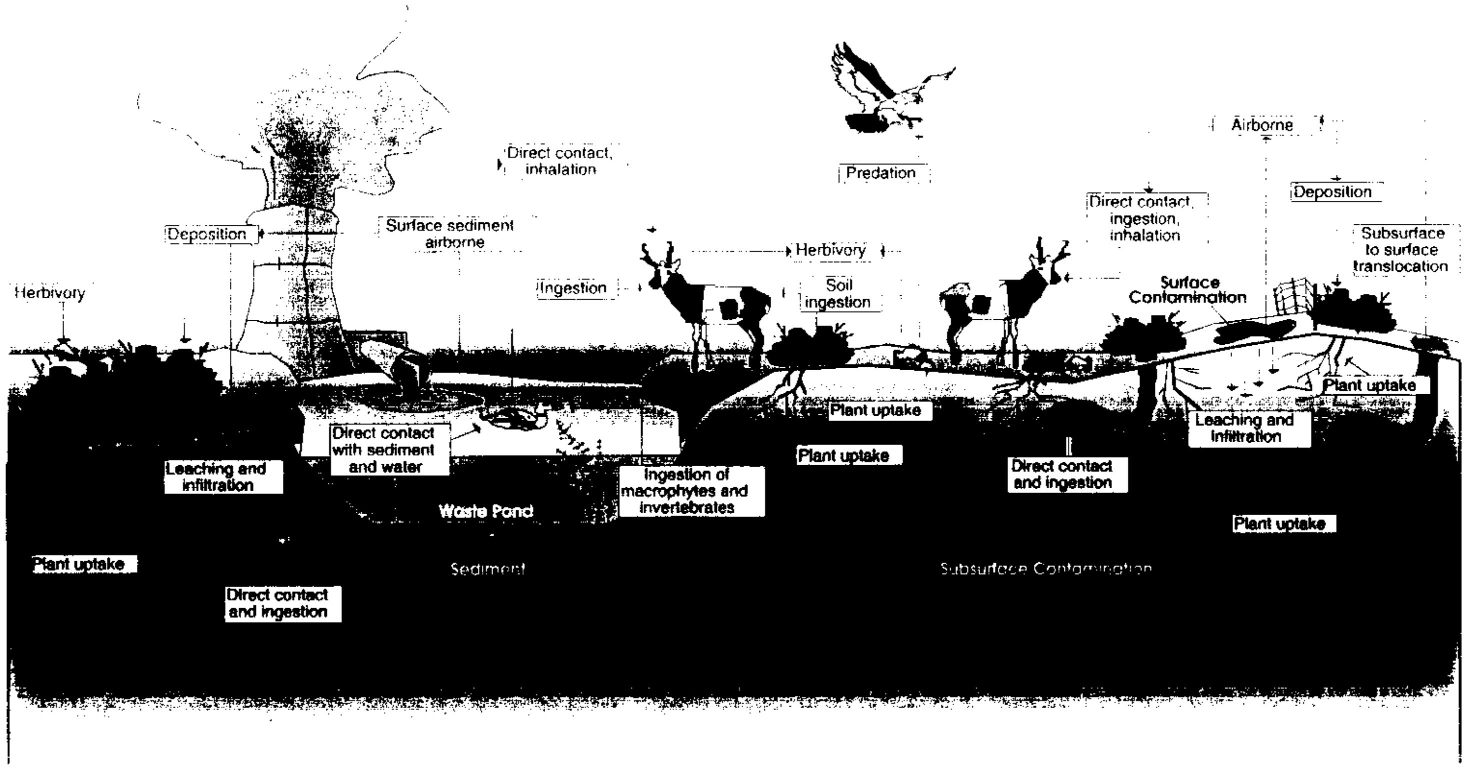

Figure 7-6. WAG 4 ecological conceptual site model.

Table 7-13. Summary of management goals. assessment endpoints and indicators of risk for WAG 4 ERA.

Management Goal	WAG Assessment Endpoint	Indicator of Risk[a]
Maintain INEEL T/E individuals and populations by limiting exposure to organic, inorganic, and radionuclide contamination.	Indication of possible effects (risk) to T/E individuals and populations as a result of contaminant exposure: peregrine falcon, northern goshawk, bald eagle, burrowing owl, ferruginous hawk, loggerhead shrike, pygmy rabbit, Townsend=s western big-eared bat, long-eared myotis, small-footed myotis, sagebrush lizard, and individuals and populations (Functional Groups AV310, AV322, AV322A, AV233, AV210, R222, M123 and M210A).	HQ[b] ≥ target value
Maintain INEEL T/E individuals and populations by limiting exposure to physical stressors.	Not addressed by WAG ERA.	N/A
Maintain survival, abundance and diversity of INEEL native biota by limiting exposure to organic, inorganic, and radionuclide contamination.	Indication of possible effects to WAG native vegetation communities as a result of contaminant exposure.	HQ ≥ target value
	Indication of possible effects (risk) to WAG wildlife populations as a result of contaminant exposure (represented by Functional Groups identified in the site conceptual model: invertebrates, waterfowl, small mammals, large mammals, song birds, raptors, top predators).	HQ ≥ target value
Maintain survival, abundance and diversity of INEEL native biota by limiting exposure to physical stressors.	Not addressed by WAG ERA.	N/A

Source: Suter 1993

a. Based on original guidance provided by EPA (1994), this column might have been called the Ameasurement endpoint.≡ Subsequent guidance from EPA (1996) now discusses measures/indicators of effects.

b. HQ = hazard quotient. The target value is 1 for nonradionuclide contaminants and 0.1 for radionuclide contaminants. The HQ approach does not consider variability and uncertainty in either exposure or toxicity estimates, and therefore does not represent a statistical probability of occurrence of adverse ecological effects. HQs provide essentially a Ayes or no≡ determination of risk and are therefore well-suited for screening-level assessments (EPA 1988b). A limitation of the quotient method is that it does not predict the degree of risk or magnitude of effects associated with specified levels of contamination (EPA 1988b).

Table 7-14. Summary of WAG 4 Ecological Risk Assessment endpoints.

WAG 4 Assessment Endpoint	Ecological component	Functional Group (other groups represented)	Measurement Species (TRV test species)
Indication of risk to T/E individuals and populations as a result of contaminant exposure.	Pygmy rabbit	M122A (M123)	Rate, mouse/meadow vole (M122A), deer mouse
	Peregrine falcon, northern goshawk	AV310	Chicken, goshawk (AV310), American Kestrel/red-tailed hawk (AV322)
	Ferruginous hawk, loggerhead shrike, bald eagle, burrowing owl	AV322, AV322A	Chicken, goshawk (AV310), American kestrel/red-tailed hawk (AV322)
	Townsend's western big-eared bat, long-eared myotis, small-footed myotis	M210A (M210)	None located
	Sagebrush lizard	R222	None located
Indication of possible effects to WAG 4 native vegetation communities as a result of contaminant exposure.	Vegetation	Sagebrush, bunchgrass	Bush beans, crop plants
Indication of possible effects to WAG 4 wildlife populations as a result of contaminant exposure (represented by functional groups identified in the site conceptual mode: small mammal, large mammals, song birds, raptors, top predators, invertebrates)	Small mammals	M422, M122A (M222, M123)	Rat, mouse/meadow vole (M122A), deer mouse (M422)
	Mammalian carnivore/omnivores	M422A, M322	Rat, mouse, dog, cat, mink/fox
	Mammalian herbivores	M122 (M121)	Rat, mouse, mule deer/pronghorn (M122)
	Mammalian insectivore	M210A, M222 (M210)	Western racer
	Avian carnivores	AV322, AV310	Goshawk (AV310), American kestrel/red-tailed hawk (AV322)
	Avian herbivores	AV122 (AV121)	Chicken, pheasant, quail, passerines/sharp-tailed and ruffed grouse
	Avian insectivores	AV210A, AV222, AV232 (AV210, AV221)	Chicken, pheasant, quail, passerines/American robin (AV222), cliff swallow (AV210A)
	Reptiles	R222, R322	Western racer/None located
	Invertebrates	Phytophagous, saprophagous, entomophagous	Unidentified

The measurement endpoints are the modeled dose as compared to the TRVs for each contaminant for each receptor functional group. The modeled dose was divided by the TRV to produce an HQ for each contaminant and receptor of concern. The HQ is ultimately used to measure whether the assessment endpoints have been attained, that is, survival and reproductive success are ensured for the receptor groups being assessed (HQs are less than the target value for all receptors for each contaminant).

7.3 Analysis

The risk analysis step of the WAG 4 ERA involves assessing exposure to contaminants (characterization of exposure) and potential effects of exposure (characterization of effects). These activities are conducted interactively to ensure that the methods used to assess exposure and effects are compatible. Assessing exposure and effects is based on the ecological endpoints and conceptual models derived during the problem formulation presentation.

A primary step in analyzing risk is to determine the potential for site-related contaminants to increase the incidence of adverse effects in exposed populations. The objective of this activity is to estimate the magnitude, frequency, duration, and route of exposure to site-related contaminants by ecological receptors. Accomplishing this task involves completing the following steps:

1. Discuss the factors that influence contaminant fate and transport.

2. Estimate dose for all functional groups and contaminants.

7.3.1 Contaminant Fate and Transport

No formal transport and fate modeling was conducted for this WAG ERA. Environmental fate properties are important because they provide information on the environmental behavior of contaminant compounds throughout various environmental media. WAG 4 surface and subsurface soil contaminants, identified in Section 7.2.6 include the following:

- 2-methylnaphthalene
- 4-methyl-2-pentanone
- acetone
- antimony
- Aroclor-1254
- arsenic
- barium
- benzo(a)anthracene
- benzo(a)pyrene
- benzo(b)fluoranthene
- benzo(g,h,i)perylene
- benzo(k)fluoranthene
- cadmium
- chloromethane
- chromium III
- chrysene
- cobalt
- copper
- dibenz(a,h)anthracene
- dibenzofuran
- indeno(1,2,3-cd)pyrene
- lead
- manganese
- mercury
- nickel
- nitrate
- pentachlorophenol
- pyrene
- selenium
- silver
- sulfate
- thallium
- TPH
- xylene
- zinc

Many of the inorganic contaminants are metals. Soils represent the most concentrated source of metals in the terrestrial environment. The health risks posed by trace metals in soils are not determined solely by their quantity. A number of contaminant, environmental, and biological conditions and processes influence the accessibility and availability of metals to organisms, and hence their toxicological significance. First, speciation is a major determinant of the fate, bioavailability, absorption, and toxicologic characteristics of metal compounds. Second, the distribution coefficient between soil and water (K_d) depends upon both the properties of the metal and the composition of the soil. This coefficient also governs the bioavailability of a metal to organisms contacting the soil, with the weakly bound metals highly bioavailable and the strongly bound metals less bioavailable. Other influential factors include: (1) the characteristics of the interface (e.g., lung, skin, intestine), (2) the reactivity of the metal with the interface, and (3) the concurrent presence of other metals or other substances that may stimulate or inhibit metal uptake. Factors that influence the fate and transport (and thereby bioavailability) of the WAG 4 COPCs are presented in Sections 7.3.4 through 7.3.6, along with discussions of the ecotoxicological effects for these contaminants.

7.3.2 Determining Exposure

Potential exposures for functional group, T/E, and sensitive species were determined based on site-specific life history and feeding habits, when possible. Quantification of group and individual exposures incorporated species-specific numerical exposure factors including body weight, ingestion rate, and fraction of diet composed of vegetation or prey, and soil consumed from the affected area. Parameters used to model contaminant intakes by the functional groups are presented in Table 7-15. These values were derived from a combination of parameters that produced the most conservative overall exposure for the group. The functional group parameters (see Table 7-15) represent the most conservative combination of percent prey, percent vegetation, percent soil, ED, ingestion rate, body weight, and home ranges from species within the functional group.

Each receptor's diet was assumed to be composed of percentages of two food types (i.e., percentages of either prey or vegetation) to simplify exposure calculations. For example, herbivorous animals are assumed to consume solely vegetation taken from the WAG 4 area (i.e., 100% of the vegetation consumed by herbivores comes from WAG 4). While this is a simplistic and conservative assumption, breaking down the diet of individual species within a functional group in more detail, while warranted, is beyond the scope of a WAG ERA. Most terrestrial receptors incidentally or directly ingest soil, and the percent of soil ingested from that affected area was also estimated. Insectivores are very conservatively modeled because of the complexity of contaminant intake from insects to insectivores, and inadequate data. Therefore, the method used for estimating contaminant concentrations in insect prey poses large uncertainty.

Exposure estimates were corrected for the WAG 4 site areas by the use of SUFs. The SUF is the WAG 4 site area (ha) divided by the species' home range (ha) to a maximum of 1. The SUF is the proportion of the site area to the home range and is not allowed to be greater than 1 (i.e., the animal can use no more than 100% of the site area). Home ranges for the functional groups and species of concern at WAG 4 are summarized in Table 7-15. A SUF of less than 1 indicates that the home range is larger than

Table 7-15. WAG 4 species parameters.

Functional groups	PP[a]	PV[b]	PS[c]	ED[d]	IR[e] (kg/day)	Nagy equation	BW[f] (kg)	HR[g] (Ha)	WI[h]
Avian herbivores (AV122)	0.00E+01	9.07E-01	9.30E-02	1.00E-00	1.46E-03	all birds	3.50E-03	5.18E-00	1.33E-03
Avian insectivores (AV210)	9.80E-01	0.00E+01	2.00E-02	6.50E-01	2.90E-03	all birds	1.00E-02	8.38E-00	2.70E-03
Avian insectivores (AV210A)	9.70E-01	0.00E+01	3.00E-02	6.50E-01	3.89E-03	passerines	1.46E-02	2.39E-00	3.48E-03
Avian insectivores (AV222)	9.07E-01	0.00E+01	9.30E-02	1.00E-00	3.07E-03	all birds	1.09E-02	3.80E-01	2.86E-03
Avian carnivores (AV310)	9.80E-01	0.00E+01	2.00E-02	1.00E-00	1.61E-02	all birds	1.39E-01	2.18E+02	1.57E-02
Northern goshawk	9.80E-01	0.00E+01	2.00E-02	2.50E-01	6.00E-02	all birds	1.05E-00	2.13E+02	6.10E-02
Peregrine falcon	9.80E-01	0.00E+01	2.00E-02	2.50E-01	4.96E-02	all birds	7.82E-01	3.31E+01	5.00E-02
Avian carnivores (AV322)	9.80E-01	0.00E+01	2.00E-02	1.00E-00	7.44E-03	all birds	4.25E-02	9.00E-00	7.11E-03
Bald eagle	9.80E-01	0.00E+01	2.00E-02	2.50E-01	1.60E-01	all birds	4.74E-00	4.94E+02	1.67E-01
Ferruginous hawk	9.80E-01	0.00E+01	2.00E-02	6.50E-01	6.19E-02	all birds	1.10E-00	5.60E+02	6.29E-02
Loggerhead shrike	9.80E-01	0.00E+01	2.00E-02	6.50E-01	7.44E-03	all birds	4.25E-02	4.57E-00	7.11E-03
Avian carnivores (AV322A)	9.70E-01	0.00E+01	3.00E-02	2.50E-01	1.73E-02	all birds	1.55E-01	1.00E+01	1.69E-02
Burrowing owl	9.70E-01	0.00E+01	3.00E-02	2.50E-01	1.73E-02	all birds	1.55E-01	1.00E+01	1.69E-02
Avian omnivores (AV422)	6.27E-01	2.80E-01	9.30E-02	1.00E-00	1.13E-02	all birds	8.02E-02	1.10E+01	1.09E-02
Mammalian herbivores (M121)	0.00E+01	9.80E-01	2.00E-02	2.50E-01	3.14E-01	mammal herbivore	5.80E-00	1.10E+01	4.82E-01
Mammalian herbivores (M122)	0.00E+01	9.37E-01	6.30E-02	1.00E-00	3.30E-03	mammal herbivore	1.10E-02	2.30E-01	1.71E-03
Mammalian herbivores (M122A)	0.00E+01	9.23E-01	7.70E-02	1.00E-00	4.27E-03	mammal herbivore	1.57E-02	3.00E-01	2.35E-03
Pygmy rabbit	0.00E+01	9.80E-01	2.00E-02	1.00E-00	4.53E-02	mammal herbivore	4.04E-01	2.80E-01	4.38E-02
Mammalian insectivores (M210)	9.80E-01	0.00E+01	2.00E-02	2.50E-01	2.11E-03	rodents	9.03E-03	2.39E-00	1.43E-03
Mammalian insectivores (M210A)	9.80E-01	0.00E+01	2.00E-02	1.00E-00	1.43E-03	rodents	4.65E-03	2.39E-00	7.88E-04
Townsend's Western big-eared bat	9.90E-01	0.00E+01	1.00E-02	1.00E-00	2.37E-03	rodents	1.10E-02	2.39E-00	1.71E-03
Small-footed myotis	9.90E-01	0.00E+01	1.00E-02	1.00E-00	1.44E-03	rodents	4.69E-03	2.39E-00	7.94E-04
Long-eared myotis	9.90E-01	-1.00E-02	2.00E-02	1.00E-00	1.77E-03	rodents	6.65E-03	2.39E-00	1.09E-03
Mammalian insectivores (M222)	9.76E-01	0.00E+01	2.40E-02	1.00E-00	1.66E-03	rodents	6.00E-03	1.24E-01	9.91E-04
Mammalian carnivores (M322)	9.23E-01	0.00E+01	7.70E-02	1.00E-00	1.66E-02	all mammals	1.78E-01	1.30E+01	2.09E-02
Mammalian omnivores (M422)	8.04E-01	1.00E-01	9.40E-02	1.00E-00	3.06E-03	rodents	1.70E-02	7.20E-01	2.53E-03
Reptilian insectivores (R222)	9.76E-01	0.00E+01	2.40E-02	1.00E-00	5.60E-05	reptile insectivores	6.61E-03	1.17E-01	0.00E+01

Table 7-15. (continued).

Functional groups	PP[a]	PV[b]	PS[c]	ED[d]	IR[e] (kg/day)	Nagy equation	BW[f] (kg)	HR[g] (Ha)	WI[h]
Sagebrush lizard	9.76E-01	0.00E+01	2.40E-02	1.00E-00	5.60E-05	reptile insectivores	6.61E-03	1.17E-01	0.00E+01
Reptilian carnivores (R322)	9.52E-01	0.00E+01	4.80E-02	1.00E-00	6.80E-03	literature value[i]	1.50E-02	3.00E-00	0.00E+01
Plants	0.00E+01	0.00E+01	1.00E-00	1.00E-00					

a. PP = percentage of diet represented by prey ingested (unitless). Herbivores = 0% prey, total PV = PV-PS; carnivores = 0% vegetation, total PP = PP - PS): and omnivores =(1.00-PS-PV)/2 for representative species.

b. PV = percentage of diet represented by vegetation ingested (unitless).

c. PS = percentage of diet represented by soil ingested (unitless). Soil ingestion from Beyer et al. (1994) and Arthur and Gates (1988) - (pronghorn, jackrabbit).

d. ED = exposure duration (fraction of year spent in the affected area) (unitless). Conventions: Residents - 0.05-1.00 (birds and migratory and transient mammals) 1.00 (small mammals); breeding – 0.05-0.65 (birds and migratory and transient mammals): summer visitors - 0.05-0.25; winter visitors - 0.05-0.25.

e. IR = ingestion rate [derived using allometric equations based on body weight (Nagy, 1987)] (kg/day).

f. BW = receptor-specific body weight (kg). Mammalian body weight primarily from Burt and Grossenheider (1976), the general literature and EPA Exposure Factors Handbook (1993a) for some species. Avian body weights from Dunning (1993).

g. Home ranges from Hoover and Wills (1987) and the general literature. Unknown = defaulted to an SUF of 1.0 (i.e., assumes 100% site use).

h. WI = water ingestion rates derived using allometric equation (EPA, 1993a).

i. Compiled from Diller and Johnson (1988).

the area affected, and it is likely that these species consume prey, vegetation, and soil from unaffected areas.

ED is based on the migratory pattern of the receptors. This is determined using the status and abundance data compiled for site species (VanHorn et al. 1995). Five status/abundance categories are represented: resident, breeding, summer visitor, migratory, and winter visitor. For year-round residents, ED is assumed to be 1 (i.e., receptors potentially spend up to 100% of the year on the assessment area). For species breeding onsite, the ED is assumed to be 0.65, (i.e., receptors potentially spend up to 65% of the year on the assessment area). For migratory summer and winter visitors, the ED is assumed to be 0.25 (i.e., receptors potentially spend up to 25% of the year on the assessment area). The most conservative ED is chosen from the functional group members to represent the functional group ED.

Food intake rates (g dry weight/day) for passerine birds, nonpasserine birds, rodents, herbivores, all other mammals, and insectivorous reptiles can be estimated using the following allometric equations (Nagy 1987). The equation for insectivorous reptiles can be conservatively assumed to be applicable to the carnivorous reptiles (R322). Because of the fact that different allometric equations may apply to different species within a group, the equations representative of all mammals and avians were used to calculate the ingestion rate for the functional groups.

$$\textit{Food intake rate} = 0.398\ BW^{0.850}\ \textit{(passerines)} \quad (7\text{-}1)$$

$$\textit{Food intake rate} = 1.110\ BW^{0.445}\ \textit{(desert birds)} \quad (7\text{-}2)$$

$$\textit{Food intake rate} = 0.648\ BW^{0.651}\ \textit{(all birds)} \quad (7\text{-}3)$$

$$\textit{Food intake rate} = 0.583\ BW^{0.585}\ \textit{(rodents)} \quad (7\text{-}4)$$

$$\textit{Food intake rate} = 0.577\ BW^{0.727}\ \textit{(mammalian herbivores)} \quad (7\text{-}5)$$

$$\textit{Food intake rate} = 0.235\ BW^{0.822}\ \textit{(all other mammals)} \quad (7\text{-}6)$$

$$\textit{Food intake rate} = 0.015\ BW^{0.874}\ \textit{(desert mammals)} \quad (7\text{-}7)$$

$$\textit{Food intake rate} = 0.013\ BW^{0.773}\ \textit{(reptile insectivores)} \quad (7\text{-}8)$$

where

BW = body weight in grams.

An equation for ingestion rates for carnivorous reptiles (R322) was compiled from Diller and Johnson (1988).

$$\textit{Food intake rate} = 0.00001 BW^{1.5}\ \textit{(carnivorous reptiles)} \quad (7\text{-}9)$$

Exposure for each functional group was calculated using best available estimates for species-specific exposure parameters. Each of the receptors was evaluated individually. Potential exposures for these species was determined based on the species' life history and feeding habits. Quantification of exposures used species-specific numerical exposure factors including body weight, ingestion rate, fraction of diet composed of vegetation or prey, and soil consumed from the affected area. Species parameters used to model intakes by the functional groups are presented in Table 7-14. These values are derived from the various key species in the functional groups. The parameters in Table 7-14 are the maximum percent prey, percent vegetation, percent soil, and ED and the maximum ingestion-rate-to-body-weight ratio and home range for each functional group because these values were the most conservative. Percent soil ingestion rate values come from the *Wildlife Exposure Factors Handbook* (EPA 1993a), Beyer et al., (1994) and site-specific data, where available.

7.3.2.1 Exposure to Nonradiological Contaminants. The exposure equation used to calculate average daily soil intake is used to calculate the dose to functional groups and T/E species. For example, dose (intake) in mg/kg body weight-day can be estimated using the following equation, as adapted from EPA's *Wildlife Exposure Factors Handbook* (EPA 1993a):

$$EE_{tot} = \frac{[(PP \times CP)+(PV \times CV)+(PS \times CS)] \times IR \times ED \times SUF}{BW} \qquad (7\text{-}10)$$

where

EE_{tot} = estimated exposure from all complete exposure pathways (mg/kg body weight-day)

PP = percentage of diet represented by prey ingested (unitless)

CP = concentration of contaminant in prey item ingested (mg/kg)

PV = percentage of diet represented by vegetation ingested (unitless)

CV = concentration of contaminant in vegetation ingested (mg/kg)

PS = percentage of diet represented by soil ingested (unitless)

CS = concentration of contaminant in soil ingested (mg/kg)

IR = ingestion rate (kg/day), food intake rate (g/day) divided by 1,000 g/kg

ED = exposure duration (fraction of year spent in the affected area) (unitless)

BW = receptor-specific body weight (kg)

SUF = site usage factor (site area divided by home range; cannot exceed 1) (unitless).

The concentration of contaminant in prey can be estimated using the equation (VanHorn et al 1995):

$$CP = CS \times BAF \qquad (7\text{-}11)$$

where

CP = concentration in prey ingested (mg/kg)

CS = concentration of contaminant in soil (mg/kg)

BAF = contaminant-specific bioaccumulation factor (unitless).

The concentration of contaminant in vegetation can be estimated using the equation (VanHorn et al. 1995):

$$CV = CS \times PUF \tag{7-12}$$

where

CV = concentration of contaminant in vegetation (mg/kg)

CS = concentration of contaminant in soil (mg/kg)

PUF = contaminant-specific plant uptake factor (unitless).

Finally, burrowing and nonburrowing animals are potentially exposed to different soil concentrations. In order to account for this, nonburrowing animals are expected to only ingest surface soils; however, their prey is still considered to be potentially exposed to subsurface conditions.

Combining Equations 7-10 through 7-12 gives the following total dose to nonradiological contaminants in mg/kg body weight-day:

for nonburrowers

$$EE_{tot} = [(PP \; x \; BAF + PV \; x \; PUF + PS) \; x \; CS_g \; x \; IR + WI \; x \; CW] \left(\frac{ED \; x \; SUF}{BW} \right) \tag{7-13}$$

and for burrowers

$$EE_{tot} = [(PP \; x \; BAF + PV \; x \; PUF) \; x \; CS_g \; + CS_s \; x \; PS] \; x \; IR + WI \; x \; CW \; x \left(\frac{ED \; x \; SUF}{BW} \right) \tag{7-14}$$

where

WI = water ingestion rate (L/d)

CS_s = surface soil concentration (mg/kg)

CS_g = the greater of the surface and subsurface soil concentrations (mg/kg)

CW = concentration of contaminant in water (mg/L).

The water ingestion is calculated using the following equations (EPA 1993a):

$$WI = 0.059 \; BW^{0.67} \text{ (for birds)} \tag{7-15}$$

$$WI = 0.099 \; BW^{0.90} \text{ (for mammals)} \tag{7-16}$$

Due to the complexity of water ingestion by reptiles, no general reptilian water ingestion equation is available. It is assumed here that desert reptiles, such as those found at the INEEL, get their water solely from prey.

The following functional groups and T/E species are considered burrowers: AV210A, M122A, M222, M322, M422, M422A, R222, R322, burrowing owl, pygmy rabbit, and the sagebrush lizard.

A summary of the contaminant-specific PUFs and BAFs for nonradionuclides contaminants are presented in Table 7-16. A more detailed discussion is included in Appendix J. PUFs for all metals are taken from Baes et al. (1984). The PUF and BAFs for organics are estimated using the Travis and Arms (1988) equation of 1.588-0.578 log K_{ow} and -7.735 + 1.033 log K_{ow}, respectively. Log partitioning coefficients (K_{ow}s) were taken from Montgomery and Welkom (1990).

7.3.2.2 Uncertainty Associated with Functional Groups. The selection of receptor parameters used is designed to ensure that each of the members of the functional groups is conservatively represented. Since all members of a functional group are considered similar, it is reasonable to assume that all members of a group will be equally exposed to site-related contaminants. Quantification of dose for each functional group is expected to provide sufficient data to assess the general condition of the ecosystem and to be adequately protective of the majority of species potentially inhabiting WAG 4. In addition, sensitive species are included on the list of receptors for which dose is calculated. Hence, uncertainty associated with the selection of receptor parameters is expected to minimally influence dose estimates.

7.3.2.3 Uncertainty Associated with the Ingestion Rate. Estimation for terrestrial receptors intake (ingestion) estimates used for the terrestrial receptors is based upon data in the scientific literature, when available. Food ingestion rates are calculated by use of allometric equations reported in Nagy (1987). Uncertainties associated with the use of allometric equations could result in either an over- or underestimation of the true dose rate, since not all of these values are known exactly.

7.3.2.4 Uncertainty Associated with the Receptor Site Usage. The calculation of dose incorporated the probability that the receptors may use or inhabit each site. The SUF is defined as the affected area (ha) divided by the home range (ha) of the receptor. If a given receptor's home range is larger than the affected area, then it is reasonable to assume that the receptor may not spend 100% of its life within the site area. Incorporation of the SUF adjusts the dose to account for the estimated time the receptor spends on the site. The less time spent on the site, the lower the dose. However, most home ranges are estimated from available literature values and allometric equations. Home range and usage of areas also vary from season to season as well as year to year (depending on the species of interest), and are difficult to measure. This uncertainty could result in either an over- or underestimation of the true dose rates.

7.3.2.5 Uncertainty Associated with the PUFs and BAFs. Using PUFs to estimate plant concentrations has the advantages that it is easy to use and requires minimum data inputs (i.e., the measured or estimated concentration of metal in soil and a PUF taken from the literature). A PUF of 0.01 indicates that the plant concentration should be 1/100th of the total concentration in soil. For this WAG ERA, PUFs for metals are taken from Baes et al. (1984). Although preference is given to studies that reported the steady-state concentration of metals in plants at edible maturity, various soil properties are not considered and data for numerous plant species (both animal feeds and those consumed by humans) are combined. However, since root uptake of metals is a complex process that depends on various soil properties (e.g., pH, CEC, and organic matter content) as well as the metal and type of plant involved, the use of generic or crop-specific PUFs taken from the literature may not accurately estimate the concentration of metals in plants for all environmental conditions and species that may occur on WAG 4.